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Effect of organic nutrition practices on papaya (cv. Surya) fruit yield, quality and soil health

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ABSTRACT

A field experiment was conducted during 2005-07 at Indian Institute of Horticultural Research, Bangalore, on papaya cv. Surya with six organic treatments along with recommended dose of fertilizers and no manure/fertilizer application. Results indicated that crop growth and fruit yield were higher in inorganic fertilizer treatment (55 t ha^{-1}) compared to organic treatments (26.9 to 38 t ha^{-1}). There was no significant variation in average fruit weight and TSS, but shelf life of the fruit was significantly higher in organic treatments (6.2 to 7.9 days) as compared to inorganic fertilizer treatment (5.1days). Among the treatments, application of 7 kg urban compost plant^{-1} or 10 kg FYM plant^{-1} was found to be ideal for improving soil health in terms of microbial population, and biochemical reaction compared to other treatments.

Key words: Papaya, organic practices, fruit yield, quality, shelf life

INTRODUCTION

Organic farming is becoming increasingly popular, with a rapidly growing global demand for organic products. It offers considerable benefits over conventional farming systems particularly with respect to sustainable yield, better quality and health hazard free produce. Fruits, often eaten raw, are more vulnerable to contamination with chemicals due to the latter's residual toxicity as compared to cereals and pulses. Thus, organic production of fruits is gaining popularity over that of other crop groups.

Papaya is grown in an area of 98,000 ha with production of 36.29 lakh tons in India (National Horticultural Board, 2009). Since papaya bears fruits and flowers round the year, it is likely to respond well to organic production systems compared to other perennial fruit crops. In almost all the states, area under papaya is increasing, and limited information is available on organic production system in this crop. Hence, the present investigation is very important in crops like papaya.

MATERIAL AND METHODS

A field trial was conducted during 2005-2007 at the experimental farm of Indian Institute of Horticultural Research, Bangalore. The soil in the experimental plot was red loam with pH 6.12, 0.73% organic carbon, 158 kg available nitrogen/ha, 13 kg phosphorus/ha and 196 kg potash/ha. There were 8 treatments details of which are as follows;

T_1**:** Recommended dose of NPK fertilizers (250g N + 250 g P_2O_5 + 500 g K_2O plant^{-1}year^{-1}),

T_2**:** 10 kg FYM plant^{-1} year^{-1}

T_3**:** 7 kg urban compost plant^{-1} year^{-1}

T_4**:** 20 kg sun hemp + 150 g rock phosphate plant^{-1} year^{-1}

T_5**:** 2 kg neem cake + 0.5 kg wood ash plant^{-1} year^{-1}

T_6**:** 18 kg rural compost plant^{-1} year^{-1}

T_7**:** 2.5 kg vermi compost + 12.5 kg sun hemp plant^{-1} year^{-1}

T_8**:** No manure or fertilizer

Nutrient content of organic manures used in the experiment is as follows:

Organic manure used	Percentage		
	N	P	K
FYM	0.91	0.166	0.88
Rural compost	1.22	0.304	0.98
Urban compost	0.86	0.284	0.80
Vermicompost	1.41	0.299	0.55

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Standard procedures

Soil samples were collected at 2 years from experimentation for nutrient and microbial analysis. Microbial properties and soil enzymes were estimated as per standard procedures. Vegetative parameters such as plant height, plant girth and number of leaves were recorded at 6 month intervals. Fruit yield was recorded periodically. Fruit quality attributes such as TSS and keeping quality of fruits were also recorded as per standard procedures. Statistical analysis of data was done based on methods given by Panse and Sukhatme (1985). Plant spacing was 1.8 m×1.8 m in the trial.

RESULTS AND DISCUSSION

Vegetative characters : Vegetative parameters such as plant height, plant girth and number of leaves at 24 months from planting were affected by various nutrient treatments (Table 1). Maximum plant height, girth and number of leaves were recorded in the recommended dose of fertilizer treatment, whereas, no manure or fertilizer treatment recorded the least. Similar results were reported by Singh and Sharma (1996) Reddy *et al* (1986), Purohit (1977), Awada and Long (1978), Jauhari and Singh (1971), and Kumar *et al* (2006). Increased growth in recommended fertilizer dose treatment was mainly attributed to sufficient availability of all the nutrients during different growth stages of the plant, compared to other treatments

Fruit yield: Fruit yield in terms of number of fruits and their weight were found to be significantly different among various treatments (Table 2). Maximum fruit yield was recorded under recommended dose of fertilizer treatment, and the least with control treatment. Similar results were reported by Kumar *et al* (2006), Reddy *et al* (1986) and Singh & Sharma (1996). The increased fruit yield was attributed to better plant growth compared to that in other

Table 1. Vegetative characters, fruit yield and quality of 'Surya' papaya as influenced by various treatments (24 months after planting)

Treatment	Plant height (m)	Plant girth (cm)	No. of leaves plant^{-1}
T_1: Recommended dose of NPK fertilizers (250 g N + 250 g P_2O_5 + 500g K_2O plant^{-1}year^{-1})	2.49	52.0	25.8
T_2 : 10 kg FYM plant^{-1} year^{-1}	2.27	40.6	19.9
T_3 : 7 kg urban compost plant^{-1} year^{-1}	2.32	46.5	23.9
T_4 : 20 kg sun hemp + 150 g rock phosphate plant^{-1} year^{-1}	2.27	47.9	20.5
T_5 : 2 kg neem cake + 0.5 kg wood ash plant^{-1} year^{-1}	2.10	36.0	20.3
T_6 : 18 kg rural compost plant^{-1} year^{-1}	2.24	44.6	21.5
T_7 : 2.5 kg vermin compost + 12.5 kg sun hemp plant^{-1} year^{-1}	2.06	42.4	19.7
T_8 : No manure or fertilizer	1.68	33.3	16.1
SEm ±	0.01	0.30	0.38
CD *(P=0.05)*	0.04	0.90	1.12

Table 2. Fruit yield and quality of 'Surya' papaya as affected by various treatments

Treatment	Fruit yield				Fruit quality		
	No. of fruits plant^{-1}	Fruit yield (kg plant^{-1})	No. of fruits ha^{-1}(000)	Fruit yield (t ha^{-1})	Average fruit weight (g)	TSS (^{o}Brix)	Shelf life (days)
T_1: Recommended dose of NPK fertilizers (250 g N + 250 g P_2O_5 + 500 g K_2O plant^{-1}year^{-1})	37.9	17.8	116.8	55.0	472.6	11.1	5.1
T_2 : 10 kg FYM plant^{-1} year^{-1}	19.9	9.7	61.3	30.0	498.2	11.4	7.6
T_3 : 7 kg urban compost plant^{-1} year^{-1}	25.2	11.8	77.7	36.5	476.5	11.3	6.6
T_4 : 20 kg sun hemp + 150g rock phosphate plant^{-1} year^{-1}	30.0	12.6	92.5	38.7	427.7	12.2	7.1
T_5 : 2 kg neem cake + 0.5 kg wood ash plant^{-1} year^{-1}	20.0	9.9	61.6	30.6	495.3	11.3	6.2
T_6 : 18 kg rural compost plant^{-1} year^{-1}	27.0	11.5	83.2	35.5	430.0	11.6	6.6
T_7 : 2.5 kg vermi compost + 12.5 kg sun hemp plant^{-1} year^{-1}	18.7	8.7	57.7	26.9	473.8	11.4	7.0
T_8 : No manure or fertilizer	12.0	5.7	39.4	17.5	441.3	12.2	7.9
SEm ±	4.6	1.9	14.4	5.9	28.5	0.28	0.66
CD *(P=0.05)*	13.7	5.6	42.4	17.3	NS	NS	0.91

Table 3. Microbial population, soil respiration and mineralizable nitrogen in organic papaya (C.V.Surya field

Treatment	Bacteria (10^8cfug^{-1})	Fungi (10^4 cfug^1)	Actionomycetes (10^5 cfug^{-1})	Total Diazotrophs (10^4 cfu g^{-1})	Soilrespiration (mg C kg^{-1}soilhr^{-1})	Soil mineralizable nitrogen (mg N kg^{-1} of soil)
T_1: Recommended dose of NPK fertilizers (250 g N + 250 g P_2O5 + 500 g K_2O plant^{-1} year^{-1})	98.4	6.0	8.3	6.3	7.19	10.5
T_2 : 10 kg FYM plant^{-1} year^{-1}	141.8	18.3	16.0	21.0	8.57	46.25
T_3 : 7 kg urban compost plant^{-1} year^{-1}	139.6	16.4	17.8	19.4	7.26	47.25
T_4 : 20 kg sun hemp + 150 g rock phosphate plant^{-1} year^{-1}	116.4	8.4	14.0	16.5	10.10	42.00
T_5 : 2 kg neem cake + 0.5 kg wood ash plant^{-1} year^{-1}	119.6	11.0	14.8	15.0	9.70	45.50
T_6 : 18 kg rural compost plant^{-1} year^{-1}	136.4	18.0	16.4	23.2	8.70	56.00
T_7 : 2.5 kg vermi compost + 12.5 kg sun hemp plant^{-1} year^{-1}	127.3	11.6	13.6	19.1	9.85	43.75
T_8 : No manure or fertilizer	80.2	5.4	9.2	7.9	5.60	14.00
SEm ±	5.70	0.61	0.66	0.79	0.40	3.55
CD *(P=0.05)*	11.67	1.25	1.34	1.63	0.81	7.28

organic treatments or control. Although yield was higher in inorganic treatment (recommended dose of fertilizer) soil quality improvement was not noticed in terms of soil microflora and soil enzymes. Fruit yield reduction was 30-51% in organic treatments as compared to inorganic treatment at two years from experimentation. This may be due mainly to higher and quick availability of nutrients for growth and development under inorganic fertilizer treatment. In addition, pest and disease problem too may have resulted in reduced fruit yield in organic treatments (although progressive nutrient built up was seen in the soil due to addition of organic manures).

Fruit quality attributes: Fruit quality attributes like average fruit weight and TSS were found to be non significant but shelf life was found to be significantly different among various treatments (Table 2). Maximum shelf life was (7.9 days) seen in control, whereas, minimum shelf life (5.1 days) was noticed in recommended dose of fertilizer treatment. The finding is quite interesting but needs to be confirmed at different locations.

Soil health: Results on soil microbial population indicated that in general bacteria, fungi, actinomycetes and total diazotrophos were significantly higher in all the organic treatments compared to no manure and recommended dose of fertilizers (Table 3). The organic treatments recorded significantly higher soil respiration and mineralizable nitrogen content compared to recommended dose of fertilizer and control treatment. The finding clearly indicated an increase in microbial population in organic treatments, which may have improved soil respiration and mineralizable nitrogen content. Reduction in soil microorganisms in inorganic fertilizer treatment could be due to toxicity from metal contaminants found in inorganic fertilizers (Marschner *et al*, 2004), In the present study, treatments that resulted in higher organic carbon content in soil had higher microbial population. Similar results were reported by Chang *et al* (2007).

The results on soil enzyme activity (Table 4) indicated that among various treatments, dehydrogenase and glusosidase activity was significantly higher in 7 kg urban compost plant^{-1} treatment, whereas acid phosphatase and urease were significantly higher in 20 kg sunhemp plus 150 g rock phosphate plant^{-1} treatment compared to control and inorganic fertilizer applied treatments. These results reveal that treatments that received FYM or compost had greater microbial population, which may have increased soil enzyme activity compared to inorganic fertilizers alone or control. Higher levels of enzyme activity have been reported by many researchers in soils treated with vermicompost and organic manure compared to inorganic fertilizers (Krishna Kumar *et al*, 2005; Chang *et al*, 2007).

Results clearly revealed that organic nutrition practices in papaya production significantly improve soil health in terms of soil microbial and biochemical properties

Table 4. Soil enzyme activity in organic papaya field (24 months after planting)

Treatment	Soil enzyme activity			Urease[4]
	Dehydro-genase[1]	βGluco-sidase[2]	Acid.phos-phatase[3]	
T_1: Recommended dose of NPK fertilizers (250g N + 250 g P_2O_5 + 500 g K_2O $plant^{-1}year^{-1}$)	27.4	69.2	86.1	29.4
T_2 : 10 kg FYM $plant^{-1}$ year	83.5	169.3	106.8	66.5
T_3 : 7 kg urban compost $plant^{-1}$ $year^{-1}$	102.4	226.2	109.2	60.2
T_4 : 20 kg sun hemp + 150 g rock phosphate $plant^{-1}$ $year^{-1}$	78.9	147.7	121.0	79.8
T_5 : 2 kg neem cake + 0.5 kg wood ash $plant^{-1}$ $year^{-1}$	69.6	141.1	112.1	63.0
T_6 : 18 kg rural compost $plant^{-1}$ $year^{-1}$	83.7	225.4	107.5	46.9
T_7 : 2.5 kg vermicompost + 12.5 kg sun hemp $plant^{-1}$ $year^{-1}$	74.7	177.5	112.3	39.9
T_8 : No manure or fertilizer	39.8	68.7	94.4	28.6
SEm	3.39	7.32	4.96	2.50
CD *(P=0.05)*	6.95	14.98	10.15	5.12

[1]. µg TPF released g^{-1} of soil h^{-1}, [2]. µg g^{-1} soil h^{-1}, [3]. µg *p*-nitrophenol released g^{-1} soil h^{-1} [4]. µg NH_4 formed g^{-1} soil h^{-1}

compared to application of inorganic fertilizers alone. Among the treatments, application of 7 kg urban compost $plant^{-1}$ or 10 kg FYM $plant^{-1}$ was found to be ideal for improving soil qualities, but fruit yield was significantly higher under recommended dose of fertilizers compared to that under organic treatments.

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